Compound in a future perspective

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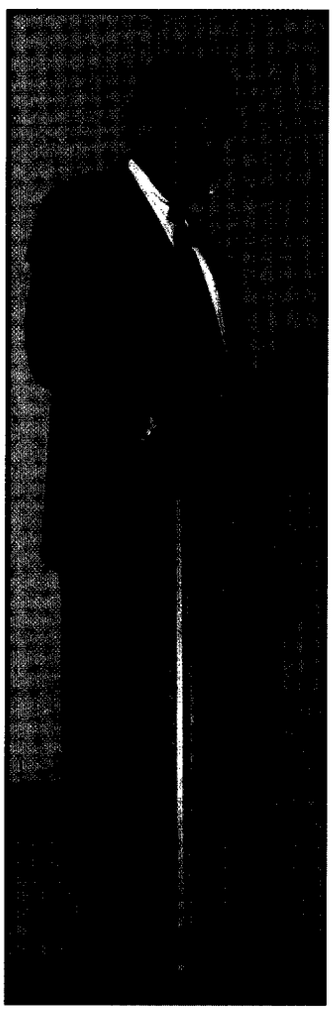
Three days after spelling out the InP challenge at IPRM, Dr John Zolper took the stand at the plenary session of GaAs Mantech at Phoenix, without any let up on ambitious targets this time for the GaAs community. Zolper spelt out the Department of Defence needs that far outstrip current commercial requirements in operating in elevated temperatures and high radiation, small target detection at long range and high rate sensor data processing in real time, as well as operating outside of commercial spectrum bands. He said that in the past this has led to development of high performance electronic components, that in turn spark commercial applications.



Dr John Zolper preaching a strenuous road map for the GaAs community

Noting that the DoD experienced a period where 'commercial off the shelf' technology was sufficient for system requirements, driven by cost reduction at expense of system performance, he saw the drive now is to transform the US military which requires electronic component technology well in excess of what is commercially available. DARPA's Microsystem Technology Office (MTO) has therefore expanded its investment into high risk, high pay-off electronics research.

Current investment in the next generation of compound materials, in the frontier of scaled silicon and SiGe technology are for DoD unique circuits. 6.1Å material (GaSb, InAs and AlSb) are expected to enable extremely low noise mm wave receivers and <1 volt mixed signal logic from their high mobility (<33,000cm^2/Vs at room temperature) and saturated electron velocity (<4x107cm/s) at low field.

The current MTO antimonide based compound semiconductor programme is developing InAs-based HEMTs and HBTs with high speed operation from 0.5 and 1volt. Wide bandgap SiC and GaN are being developed for both power conversion and high frequency amplifiers. Phase I focuses on establishing the substrate and epi material quality and uniformity for large area power devices and complex microwave circuits during Phase II.

Two MTO programmes are targeting complex mixed signal circuits such as direct digital synthesisers and analog-to digital converters. Technology for Efficient Agile Mixed Signal Microsystems (TEAM) exploits integration of aggressively scaled SiGe HBTs for clock frequencies in the 10s of GHz with cutoff frequencies over 350GHz. TEAM is to explore circuit topologies enabled by integrating mixed bipolar and CMOS circuits for high precision. The second programme is InP's TFAST (see p 32).

Embedded real time intelligence

Beyond the development of the new materials and device structures MTO is hunting for a new class of intelligent, configurable components, where the operating conditions eg., bias point, efficiency, bandwidth, centre frequency etc, can be changed in real time in response to autonomous sensors or digital control embedded in the components.

Intelligent Microsystems' seek to exploit the technology overlap of traditional analog and mixed signal electronics with MEMS and other dynamic circuit controls. To achieve this the functionality of different materials systems and device types must be seamlessly interfaced at the device, circuit and sub-module level. This will require heterogeneous integration and design tools modelling complex interfaces with multiple device models. The core circuit and microsystems will exploit 3D topologies to minimise signal and clock paths and optimise overall performance.

Intelligent RF Front Ends (IRFFE) aims to embed digital control in analog RF components for real time control and optimisation. That requires real time sensing of the waveform and dynamic reconfiguration of the input and output matching networks to alter the output for changing environmental conditions or other requirements.

This combination of multiple materials and devices within closely spaced microsystems means that heat management and removal will become an ever more critical component and it will require the inclusion of advanced thermoelectrical cooling